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TITLE OF THESIS/*TITRE DE LA THÈSE* THE STIMULUS COMPONENT INDEPENDENCE PHENOMENON

UNIVERSITY/*UNIVERSITÉ* UNIVERSITY OF ALBERTA

DEGREE FOR WHICH THESIS WAS PRESENTED/ *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* M. Sc.

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* 1975

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THE UNIVERSITY OF ALBERTA

THE STIMULUS COMPONENT INDEPENDENCE PHENOMENON

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF PSYCHOLOGY

EDMONTON, ALBERTA

FALL, 1975

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "The Stimulus Component Independence Phenomenon", submitted by Randolph Michael John Petruk in partial fulfilment of the requirements for the degree of Master of Science.

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Abstract

Evidence for the formation of intercomponent associations between the letters of an unintegrated trigram was examined using a paired-associate procedure. Upon reaching criterion learning, subjects were tested for existence of associations formed between the stimulus components and the response. Although an attempt to limit the formation of backward associations during list acquisition was unsuccessful, several item analyses were carried out. It was shown that if a component could not elicit a response, it seldom elicited another component, and as long as a mediational chain between two components was intact the components could elicit each other with a high probability. These data are consistent with those of Martin (1971), and support the notion that components enter into independent associations with the response during list acquisition, but do not eliminate the possibility that the pattern of results is due to inattention to some components. Analyses of the components operationally defined as attended indicated mediation through a common response was not necessary for one component to elicit another. This data was interpreted to mean that intercomponent associations can, and do, form during list acquisition.

Acknowledgments

I wish to express my gratitude to Dr. A.R. Dobbs for his immeasurable contribution towards the completion of this study, and to my wife, Yvonne, for her many hours of typing and proofreading. With their patience and encouragement they made a difficult task challenging and rewarding.

I would also like to thank Dr. W.N. Runquist and Dr. R.B. Wilberg for serving as members of the thesis committee, and for their thoughtful criticisms of the study.

The efforts of Percy Zalasky in collecting the data were also appreciated.

This research was supported by NRC Grant APA-335 awarded to Dr. A.R. Dobbs.

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Introduction

Implicit in much of the research on stimulus selection is the notion that, regardless of intent, the learner comes to acquire associations between stimulus components. To the extent that direct component-component associations are formed, difficulties arise in the interpretation of stimulus selection tests. In discussing stimulus selection phenomena, Underwood (1963) warned that response recall given the presentation of a particular component does not necessarily imply that an association between that component and the response was acquired. Instead, response recall could be mediated through another component. That is, presentation of component A_i may lead to recall of component A_j and A_j in turn may serve as a stimulus for the recall of the response. Here an association between A_i and the response need not be present for correct response recall to occur when A_i is presented.

A similar emphasis on the formation of component-component associations was offered by Postman and Greenbloom (1967). They found that the probability of response recall increased with the number of other stimulus elements that could be reproduced. These increases were assumed to reflect mediation through other components. Based on their findings, Postman

and Greenbloom proposed a dual criterion for the identification of elements that had been selected and used in S-R association formation. This criterion necessitated response recall in the absence of the reproduction of other stimulus components. Clearly, the stated necessity for the dual criterion rests on the assumption that component-component associations are indeed formed.

More recently, Martin (1971) has questioned the incidence of component-component association formation. Like Postman and Greenbloom (1967), Martin also reported that the probability of response recall rises with the reproduction of other stimulus components. Furthermore, he showed that when the response was correctly recalled, the number of components increased as a function of the degree of list learning. However, when the learner failed to recall the response, the proportion of other components recalled was found to be essentially zero and unrelated to the degree of list learning. On the basis of these data, Martin proposed a component independence hypothesis in which it was suggested that each component which enters into an association with the response does so independently of the other components. Direct component-component associations were assumed not to be formed during list acquisition. Within the framework of the component independence hypothesis, the only

way one component can serve as a cue for the recall of another is when mediation through the common response takes place.

In considering the evidence relevant to the component independence issue, Postman and Underwood (1973) raised two objections. One objection concerned the generality of the findings. A re-analysis of the Postman and Greenbloom (1967) data indicated substantially higher probabilities of component recall in the absence of response recall with relatively unintegrated materials. These probabilities ranged from .22 to .41 and would seem to be too large to be attributed to pre-experimental associations or guessing, as required by Martin's hypothesis. Postman and Underwood suggested that an unusually small amount of component-component association formation may have taken place in Martin's (1971) study because of the nature of the materials employed: sets of three four-letter words paired with another four-letter word. However, it could be the case that the materials used in the Postman and Greenbloom study predisposed the greater indication of component-component association formation. The compound stimuli used were hard to pronounce trigrams (mean = 7.6 and 7.8 for each list) taken from the Underwood and Schulz (1960, Appendix E) norms. An inspection of the pool from which these items must have been drawn,

suggests that at least some of the items may have been pronounced or treated as a unit by adding a letter to form a word. To the extent this occurred, pre-experimentally established language habits were reflected, rather than component-component associations formed during list acquisition.

The second criticism made by Postman and Underwood (1973) concerned Martin's interpretation of the data. They suggest that failure to recall the response upon presentation of a stimulus component can be taken as evidence that the component was simply not attended to. Thus, subjects would not only fail to give a correct response to the component, but also fail to give other components as well.

Despite these criticisms, the argument made by Martin in support of stimulus component independence is somewhat compelling, particularly in the light of data presented by Dobbs and Horton (1974). This latter study failed to find any substantial amount of component recall in the absence of response recall, with different sets of unintegrated consonant-consonant-consonant (CCC) stimulus materials and selection variables, across fifteen independent groups. Nevertheless, both the Martin (1971) and Dobbs and Horton data are equivocal support for the independence notion since inattention

to some components as an alternate interpretation of the phenomenon was never eliminated.

One purpose of the present study was to re-examine the stimulus component independence argument by excluding from consideration all instances where there is no evidence of attention to a stimulus element. This would insure that any failure of component recall cannot be attributed to inattention of a particular component cue. A component can be operationally defined as attended if it entered into an association with the response or any component of the trigram. That is, if component A_i can elicit component A_j, A_k or the response, or be recalled when A_j, A_k or the response is presented, A_i can be said to have been attended. It must be emphasized that a recognition criterion for attention is not appropriate in the present context. As Postman and Underwood (1973) point out, a component that does not enter into any association cannot serve as a recall cue for another component or the response. Similarly, components that can be recognized but not associated are, also by definition, components that cannot serve as effective recall cues. For the evidence of stimulus component independence to be convincing, an analysis restricted to the subset of the associated elements must demonstrate a negligible degree of component recall when no response recall was possible.

If this contingency is not found when only these attended items are considered, it would suggest that the pattern of results presented by Martin (1971) is due to an attentional artifact.

A second purpose of the present investigation was to examine the component independence notion when the possibility of response mediation was limited. Since mediated component recall can only occur by means of a backward association, the independence hypothesis predicts that changes in the number of backward associations should lead to differential degrees of intercomponent association formation. Based on this rationale, an experimental procedure suggested by Wollen and Gallup (1968) was employed. They have indicated that removing the opportunity for intratrial repetition limits the formation of backward associations. By the same reasoning, an analysis of individual items in which no backward associations are evident should show few intercomponent associations. If mediation through a common response is necessary for one component to elicit another, both methods should be appropriate for a test of the stimulus component independence hypothesis.

Method

Design and procedure. The design was a 2 x 2 factorial with the method of presentation (blocked or random) and stimulus materials (trigrams or letters) as factors. The study trials in the blocked condition consisted of alternately presenting the stimulus and response of a single item, three times in succession. In the random condition the stimulus also preceded the response, and each stimulus-response pair was presented three times on each study trial. However, the presentation orders were designed so that no single S-R combination was presented twice in succession.

With both the blocked and random presentation, each stimulus and response was presented for approximately .5 sec. To help distinguish stimuli from responses at this rapid rate of presentation, the stimuli were on the left side of the screen and the responses were on the right side. On test trials the stimulus terms were presented for 2 sec. and subjects were asked to recall the correct response term. The complete set of the instructions used in this study can be found in Appendix A.

The purpose of these methods of presentation was to build in backward associations in the blocked condition and to minimize their formation in the random

condition. Wollen and Gallup (1968) have used this procedure successfully, and suggest that the rapid, repeated presentation of the S-R pair allows covert practice of the R-S association. Contrarily, the random presentation of items does not encourage practice of R-S associations because the stimulus never immediately follows the response. Thus differential degrees of backward association formation should be manifested in each condition.

The blocked and random presentation procedure was used in each corresponding condition to present a five-item practice list for five trials. The items consisted of color-name stimuli paired with two-syllable adjectives. There were two study-test orders. Appendix B contains a listing of all stimulus materials used in the present study.

After the practice list, subjects in both the blocked and random condition were given the second list in which the stimuli were either low m (unintegrated) CCC's or single consonants. The trigram-response pairings were TLN-KING, FCP-NATION, ZSG-BUTTER, XJM-TREE, RKH-PEOPLE, and BQD-IRON. In the letter condition, the pairs were identical except that only the first letter of each trigram was used as the stimulus. Three study and test orders were used and all subjects were taken to a criterion of one errorless trial. Subjects who

did not reach this criterion within 30 trials were dropped from the study. Four subjects in the random trigram, two in the random letter and one in the blocked trigram group were replaced because of this restriction. Upon completion of second-list acquisition, subjects were given an unpaced recall task. For the trigram groups the 18 individual letters of the trigrams and the 6 response words were presented. When a letter was shown, the subjects were instructed to give the remaining two letters of the trigram and the response. If the response was presented, subjects were to give the three letters that were paired with the response. Each letter and response was presented once. Subjects in the letter subgroups were given only the six individual letters and the responses from their list, and asked to provide the remaining members of the item.

Because several changes in the Wollen and Gallup (1968) procedure were made, the letter control condition was included in the present study to assess the effectiveness of these modifications for eliminating backward associations, when compound stimuli were not used.

Subjects. Each of the four groups were composed of 10 males and 10 females who volunteered as an option for credit in an introductory psychology course. These

students were assigned to groups in order of their appearance in the laboratory, with the restriction that each group must have n-1 subjects prior to the assignment of the nth subject to any group.

Results

Appendix C contains a complete subject by subject listing of the data from which all analyses in this section were conducted.

Practice list. Over the five practice-list trials, the random procedure led to fewer correct responses ($\bar{X}$ = 12.4), than the blocked method ($\bar{X}$ = 17.3). The F (1, 76) for this comparison was 16.2, $p < .001$. Neither the pseudo-classification of trigram vs. letter or the interaction with the method of presentation gave any indication that the groups differed in ability, both F's (1, 76) < 1.00. The relative decrement obtained with the random procedure may have been due, in part, to a decrease in strength of the backward associations.

List 2. The mean trials to reach the criterion of one perfect recall of List 2 were reliably different for the blocked and random methods of presentation (blocked = 7.72, random = 12.68), F (1, 76) = 12.05, $p < .001$. The stimulus variable (letters = 9.43, trigram = 10.98) did not affect performance, F (1, 76) = 1.18, nor did it interact with the method of presentation, F (1, 76) = 2.38, $p > .10$.

Selection data. Despite the unconventional method of presentation, the selection data appeared to be

consistent with that of other researchers (e.g. Postman and Greenbloom, 1967; Nelson and Rowe, 1969; Jenkins, 1963). Table 1 shows the proportion of response recalls when letters in various positions of the trigram were presented individually. It is evident that with both the blocked and random method of presentation, the letter from the first position was a more effective cue for retrieving the response than those from the other positions. Duncan multiple range tests indicated reliably greater selection of the first component than either the second or third components in both conditions, $p < .001$. In neither condition did the differences between the second and third position reach acceptable levels of significance, p's $> .10$, nor was there a reliable interaction between conditions and stimulus position, $F < 1.00$.

The level of stimulus recall obtained when the responses were used as cues provides a measure of the degree to which the formation of backward associations were limited in each condition. When letters served as a cue during learning, the blocked condition led to 5.75 (out of 6) stimulus recalls, compared to 5.30 in the random condition. This difference is reliable, F (1, 38) $= 4.28$, $p < .05$. However, the number of components recalled did not reliably differ as a function of the method of presentation in the trigram groups, although

Table 1

Proportion of Total Response Recall as a Function of the Letter Position in the Trigram

	Letter Position			
Group	1	2	3	X
Blocked	.717	.300	.275	.431
Random	.750	.192	.234	.392

a trend in the predicted direction was evident. The mean correct (out of 18) was 9.25 for the blocked condition and 7.40 for the random condition, F (1, 38) = 3.95, $p < .10$. Similarly, there was no difference in the mean number of times that at least one component from a trigram was recalled when the response was presented, (blocked = 5.15, random = 5.00), F (1, 38) < 1.00. Taken together, these results suggest that the attempt to limit backward association formation was not successful. Even in the letter condition where an acceptable level of significance was attained, the differences in the number of correct stimulus recalls indicated a weak effect. This unexpected outcome may have occurred because subjects in the Wollen and Gallup (1968) study were given paced recall tasks and taken to a 4/8 criterion. It is possible that the corresponding differences in the present procedure led to the greater number of backward associations observed in the current study.

Nevertheless, the mediation assumption of the stimulus component independence hypothesis can be evaluated by considering only those items for which no backward association was evident from the selection test. This analysis is indentical to that proposed by Martin (1971) and is shown in the first four rows of Table 2. Here the probability of recalling zero and one or two components is given when the responses were either

Table 2

Proportion of Components Recalled Given Either Response Recall or Response Recall Failure[1]

Group	Components Recalled	
	0	1 or 2
Response Recall		
Blocked	.38 (50)	.62 (105)
Random	.54 (68)	.46 (73)
No Response Recall, All Components		
Blocked	.84 (172)	.16 (33)
Random	.94 (205)	.06 (13)
No Response Recall, Attended Components		
Blocked	.53 (40)	.47 (33)
Random	.86 (48)	.14 (13)

[1]Numbers in parentheses indicate the number of instances contributing to each proportion.

recalled or not recalled. Note from the last column of the third and fourth rows that the probability of recalling a component is very small in cases of response recall failure, although the difference between groups is reliable, F (1, 38) = 6.99, $p < .025$. Furthermore, the means of the last column of the first two rows indicate that these probabilities rise substantially in each condition when the responses can be elicited by the presented component. This data appears to support the hypothesis that response mediation is necessary for a component to elicit another component. Response recall failure seems to preclude the recall of other components. However, none of the preceding analysis rule out the possibility that component independence is an "artifact" of inattention to some elements. In this respect, response recall failure and a subsequent inability to recall other components could be interpreted to mean that the components were simply unused in any association. To eliminate this possibility, a stimulus component was considered to have been attended only if there was evidence that it entered into an association with another stimulus element or the response. Martin's (1971) analysis was repeated using this item pool. As can be seen from the last column of the fifth and sixth rows of Table 2, there is an appreciable probability of

component recall given no response recall when only these items are considered. Once again the blocked condition showed reliably more component recall than the random condition, F (1, 38) = 13.97, $p < .001$. Clearly, the independence hypothesis would not have predicted the magnitude of direct component-component associations found in this latter analysis.

One other test of the independence notion can also be made. Because response mediation is assumed to be the only method by which one component can come to elicit another, very little component recall should be manifested whenever the mediational chain is broken. That is, if some component A_i can elicit a response but the response cannot elicit some component A_j, then the probability of A_i serving as an effective cue for the retrieval of A_j should be negligible. The first column of Table 3 indicates that when no attentional restriction is placed upon the components that enter the analysis, the probability of component recall is minimal. Contrarily, when the mediational chain is intact, so that presentation of A_i yields the response and presentation of the response elicits A_j, the probability of recalling A_j given A_i is very high. The second column of Table 3 contains these probabilities. The data of these last two comparisons are consistent with the independence hypothesis; only when the possibility of response mediation exists, can a component serve as an effective retrieval cue for the

Table 3

Proportion of Components Recalled Given Mediation or No Mediation for all Items and Attended Items[1]

Group	No Mediation (All Items)	Mediation (Attended Items)	No Mediation (Attended Items)
Blocked	.08 (14)	.88 (153)	.37 (14)
Random	.08 (14)	.66 (84)	.53 (14)

[1]Numbers in parentheses indicate the number of instances in each proportion. The proportions under the mediated column are for all items as well.

recall of another component.

This interpretation is equivocal, however. When the mediational chain is intact, all components are, by definition, attended. The large proportion of component recalls may also be due to direct component-component associations. An analysis of the components that are attended when the mediational chain does not exist should eliminate this possibility. If the independence notion is viable, it would be anticipated that even with elements that are attended, very little component recall should occur when response mediation is not possible. From the third column of Table 3, it can be seen that these probabilities are substantially greater than zero, and not supportive of the stimulus component independence hypothesis.

Discussion

The most noteworthy feature of the present study is the apparent support for the independence notion when all components are considered, and the emergence of contradictory evidence when only the attended elements enter the analysis. The major question that arises is, what data serves best as a test of the independence assumption? The position taken here is that consideration of only the attended elements is appropriate and necessary for resolving the independence issue.

An analysis of the attended components does not violate any assumptions made by the independence hypothesis. A strict interpretation of stimulus component independence allows integration of the stimulus elements to occur only by response mediation during list acquisition. The probability of component recall given no response recall should be very small with the subset of attended elements because they can only enter into direct associations with the response. Thus an examination of the attended items can in no way bias a test of the hypothesis.

Although not explicitly stated, Postman and Underwood (1973) have considered an association to be necessary for attention to be inferred. If subjects do not recall a response to a particular component, it

can be surmised that the component did not enter into any associations. In such cases response recall failures and the inability to recall other stimulus elements are inevitable occurrences. By including every instance of a nonattended component in his analysis, Martin (1971) minimized the evidence of component-component associations. In fact, the greater the selection behavior of the learner and the more unintegrated the compound stimuli are, the more Martin's analysis guarantees a reduction in the probabilities supporting his argument. This reduction, however, is not due to component independence but rather to the selection behavior on the part of the subject.

It may be argued that all components are attended or observed, but for a variety of reasons, never enter into associations with other components or the response. Demanding a stringent criterion for attention places an unfair burden on the test of the independence hypothesis, since instances of no response recall and component recall failures are supportive of Martin's position. Dropping several of these cases from consideration may merely reflect a relative increase in the number of pre-experimental associations, thereby inflating the degree to which component-component associations appear to exist.

Two findings mitigate against this possibility. First, the number of pre-experimental associations between component letters was designed to be minimal. Calculations from the Underwood and Schulz (1960, Appendix F) norms indicate that the expected probability of a pre-experimental association for any one item on the recall task is .014. The small number of pre-experimental associations cannot alone account for the increases of the proportions observed. A second difficulty for stimulus component independence is introduced by the different levels of component-component associations found in the blocked and random conditions using the analysis corrected for attention and that proposed by Martin. Because Martin assumes that direct component-component associations are not formed during list acquisition, these differences would have to reflect differences in the relative magnitude of pre-experimental associations between groups. Why these differences should exist when similar groups are given the same list is not clear. An explanation of these data that is not constrained by the independence assumption is simple: differential degrees of direct intercomponent association formation take place during list acquisition. These differences could be due to the successive sampling of components from the same trigram during blocked presen-

tation. Some component A_i may be selected on the first presentation of the stimulus compound and some component A_j on the immediately following presentation. Since there is a large probability that the next item sampled in the blocked condition is from the same trigram, there may be some association formed between the two elements A_i and A_j. In the random condition, any such association is necessarily made between components of different trigrams, and fewer intercomponent associations are developed.

The control for attention also seems critical in assessing the generality of the data pertinent to the independence issue. Recall that Martin (1971) and Dobbs and Horton (1974) found virtually no component recall when the responses were not recalled, while Postman and Underwood (1973) reported more substantial probabilities. The data from the present study suggests a resolution of these divergent findings. When all items are considered, the critical probabilities are in accord with those of Martin, while an analysis of the attended components gives values not unlike those reported by Postman and Underwood. The higher values reported by the latter researchers may be due to integration arising from pronounciation of the trigram. Whether this integration is due to pre-experimental associations or to intercomponent association formation during list acquisition,

it indicates greater attention to the stimulus components, and thus, larger component recall probabilities when no response recall occurs. Direct support for this interpretation comes from a re-analysis of the Dobbs and Horton (1974) study. An examination of the attended components in the three groups not given a set for selection, indicated the mean probability of component recall given no response recall was .43. This increase would seem to suggest that increments in attention led to the formation of more intercomponent associations. The divergent data reported by various researchers may be attributable to differential degrees of attention given to components of the compound stimuli in each study.

In overview, it seems that the stimulus component independence phenomenon arises largely from the tests used to determine its existence. The data of the present study indicate that direct component-component associations can, and do, form during list acquisition.

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APPENDICES

APPENDIX A

INSTRUCTIONS TO SUBJECTS

PRACTICE LIST (BLOCKED CONDITION)

The purpose of this experiment is to determine some conditions which produce changes in the way people learn verbal material. Because this study is expected to contribute to the understanding of the language process, it is important that we have your full cooperation. Please follow instructions carefully. If for any reason you are unable to follow the instructions, let me know about it at the end of the session.

The learning material consists of a color-name paired with an adjective. Your task is to learn a list of five such items. That is, you are to associate or connect the color-word on the left with the adjective on the right so that you will be able to say the adjective when the color-words are presented alone.

The procedure is a simple one. There will be alternating study and test trials. On study trials, the color-name will appear, for a very brief time, in the window before you and it will be followed by the adjective it is paired with.

This same pairing will be repeated in the same fashion two more times very quickly and then another item will be presented in the same way three times, and so on, until all the five color-adjective pairs have been shown.

Study the items silently as they appear. Do not

concentrate all your efforts on just a few pairs. Instead study each set as it is presented.

On test trials only the color on the left will be presented. You must attempt to say the adjective it was paired with before the next item appears.

The appearance of a yellow tape in the window indicates that you have finished one type of trial and are ready to begin another type of trial.

There are some other points that must be clear before we start:

1). It is important that you try to say the correct answer on every test trial, regardless of whether you got all of the pairs or none of them correct on the preceding trials. Your job is to learn the list as well as you can in the time allotted. I will tell you when to stop.

2). If you think you know the adjective that goes with a particular color-word but you are not certain, I would like you to guess. Errors will not count against you in any way.

3). On test trials, always call out the adjective immediately after the color it goes with has appeared. You have in each case only a short period of time to think of and say the correct word. If you say it after the

drum turns to the next item, it will not be counted.

4). Finally, if you find that you cannot get very many pairs correct after the first few trials, do not let this discourage you. Because of the very short period of time in which the items are presented on study trials, most people have found learning a list of this type more difficult than it appears it should be.

Are there any questions?

PRACTICE LIST (RANDOM CONDITION)

The purpose of this experiment is to determine some conditions which produce changes in the way people learn verbal material. Because this study is expected to contribute to the understanding of the language process, it is important that we have your full cooperation. Please follow instructions carefully. If for any reason you are unable to follow the instructions, let me know about it at the end of the session.

The learning material consists of a color-name paired with an adjective. Your task is to learn a list of five such items. That is, you are to associate or connect the color-word on the left with the adjective on the right so that you will be able to say the adjective when the color-words are presented alone.

The procedure is a simple one. There will be alternating study and test trials. On study trials, the color-name will appear, for a very brief time, in the window before you and it will be followed by the adjective it is paired with.

A second color-name will then be shown for a short period of time, then the adjective it was paired with and so on until each of the five color-name pairs have been shown three times each.

Study the items silently as they appear. Do not concentrate all your efforts on just a few pairs.

Instead study each set as it is presented.

On test trials only the color on the left will be presented. You must attempt to say the adjective it was paired with before the next item appears.

The appearance of a yellow tape in the window indicates that you have finished one type of trial and are ready to begin another type of trial.

There are some other points that must be clear before we start:

1). It is important that you try to say the correct answer on every test trial, regardless of whether you got all of the pairs or none of them correct on the preceding trials. Your job is to learn the list as well as you can in the time allotted. I will tell you when to stop.

2). If you think you know the adjective that goes with a particular color-word but you are not certain, I would like you to guess. Errors will not count against you in any way.

3). On test trials, always call out the adjective immediately after the color it goes with has appeared. You have in each case only a short period of time to think of and say the correct word. If you say it after the drum turns to the next item, it will not be counted.

4). Finally, if you find that you cannot get very many pairs correct after the first few trials, do not let this discourage you. Because of the very short period of time in which the items are presented on study trials, most people have found learning a list of this type more difficult than it appears it should be.

Are there any questions?

LIST II (TRIGRAM GROUPS)

In the next part of this experiment six items will be presented in the same manner as in the list you have just learned. However, the list will differ from the last list in that three letters will occur on the left and they will be paired with a noun on the right. Your task will be to recall aloud the correct noun when the letters on the left are presented alone during the test trials.

Are there any questions?

LIST II (LETTER GROUPS)

In the next part of this experiment six items will be presented in the same manner as in the list you have just learned. However, the list will differ from the last list in that one letter will occur on the left and it will be paired with a noun on the right. Your task will be to recall aloud the correct noun when the letter on the left is presented alone during the test trials.

Are there any questions?

RECALL INSTRUCTIONS (TRIGRAM GROUPS)

As you will recall, the list you learned consisted of three letters paired with a noun, I will now present to you each of the letters and nouns one at a time. As I present each one separately, you task will be to write down the three other elements that were paired with it on the list you learned. For example, when a letter appears in the window, your task will be to recall and write down the noun and the other letters that were paired with it on the last list. If a noun appears, you are to write the letters that went with the noun on the last list. Write your answers to the first item on the lines in the first row, the answers to the second item on the second row of lines and so on. It does not matter which order you write the answers. If you can remember only one component, that is fine, but be sure to write that one down. You need not rush as you will have ample time.

Are there any questions?

RECALL INSTRUCTIONS (LETTER GROUPS)

As you will recall, the list you learned consisted of a letter paired with a noun. I will now present to you each of the letters and nouns one at a time. As I present each one separately, your task will be to write down the other element that was paired with it on the list you learned. For example, when a letter appears in the window, your task will be to recall and write down the noun that was paired with it on the last list. If a noun appears, you are to write the letter that went with the noun on the last list. Write your answers to the first item on the line in the first row, the answers to the second item on the second line and so on. You need not rush as you will have ample time.

Are there any questions?

APPENDIX B

STIMULUS MATERIALS

PRACTICE LIST

STIMULUS AND RESPONSE PAIRS

STIMULUS TERMS	RESPONSE TERMS
BROWN	ROYAL
YELLOW	SPOKEN
BLUE	DOUBLE
GREEN	CRAZY
RED	ENTIRE

LIST II

STIMULUS AND RESPONSE PAIRS

STIMULUS TERMS	RESPONSE TERMS
TLN	KING
FCP	NATION
ZSG	BUTTER
XJM	TREE
RKH	PEOPLE
BQD	IRON

APPENDIX C

DATA

PRACTICE LIST TOTAL CORRECT

BLOCKED TRIGRAM

S#	Trial 1	2	3	4	5	Total
1	2	1	1	2	2	8
[illegible]	1	2	3	3	5	14
3	2	4	3	5	5	19
4	0	2	2	2	2	8
5	0	4	4	5	5	18
6	2	3	4	5	5	19
7	0	2	4	4	5	15
8	1	2	2	2	3	10
9	1	3	3	5	5	17
10	2	5	5	5	5	22
11	3	4	5	5	5	22
12	4	5	5	5	5	24
13	1	3	5	3	5	17
14	3	5	5	5	5	23
15	2	5	5	5	5	22
16	0	2	4	2	3	11
17	1	2	3	3	1	10
18	4	5	5	5	5	24
19	3	4	5	5	5	22
20	0	4	4	5	5	18
Total	32	67	77	81	86	343
Mean	1.60	3.35	3.85	4.05	4.30	17.15

PRACTICE LIST TOTAL CORRECT

BLOCKED LETTER

S#	Trial 1	2	3	4	5	Total
21	0	4	4	3	5	16
22	3	5	5	5	5	23
23	0	2	2	3	4	11
24	1	4	4	4	5	18
25	2	1	1	3	4	11
26	1	4	5	5	4	19
27	1	2	3	3	5	14
28	3	4	4	5	4	20
29	1	2	3	3	4	13
30	0	4	5	5	5	19
31	3	3	4	4	5	19
32	3	5	5	5	5	23
33	2	1	4	2	5	14
34	1	1	3	5	4	14
35	0	2	4	5	5	16
36	0	5	5	5	5	20
37	3	5	5	4	5	22
38	2	1	4	4	5	16
39	2	5	5	5	5	22
40	1	3	4	5	5	18
Total	29	63	79	83	94	348
Mean	1.45	3.15	3.95	4.15	4.70	17.40

PRACTICE LIST TOTAL CORRECT

RANDOM TRIGRAM

S#	Trial 1	2	3	4	5	Total
41	0	2	0	2	3	7
42	1	1	2	2	3	9
43	1	2	2	4	2	11
44	1	3	5	5	5	19
45	0	0	0	1	2	3
46	1	2	3	3	4	13
47	2	2	4	4	3	15
48	0	0	0	2	1	3
49	2	2	2	2	2	10
50	2	3	3	5	4	17
51	1	2	1	2	3	9
52	3	4	5	4	4	20
53	2	3	2	4	3	14
54	3	5	3	5	5	21
55	2	3	3	4	3	15
56	0	4	5	5	5	19
57	1	0	1	3	1	6
58	3	5	5	5	5	23
59	1	2	2	4	4	13
60	0	4	3	3	5	15
Total	26	49	51	69	67	262
Mean	1.30	2.45	2.55	3.45	3.35	13.10

PRACTICE LIST TOTAL CORRECT

RANDOM LETTER

S#	Trial 1	2	3	4	5	Total
61	0	1	0	3	3	7
62	0	3	3	2	2	10
63	0	0	0	1	2	3
64	2	0	2	3	1	8
65	2	3	4	3	4	16
66	1	2	2	2	1	8
67	0	1	1	1	1	4
68	2	2	1	4	3	12
69	0	2	2	2	1	7
70	1	1	1	1	3	7
71	1	0	0	1	0	2
72	0	5	4	5	5	19
73	1	3	5	5	5	19
74	4	3	5	4	5	21
75	1	1	2	4	4	12
76	1	2	1	2	5	11
77	1	2	2	1	3	9
78	1	3	4	4	4	16
79	4	5	5	5	5	24
80	3	2	4	5	5	19
Total	25	41	48	58	62	234
Mean	1.25	2.05	2.40	2.90	3.10	11.70

LIST II TRIALS TO SUCCESSIVE CRITERIA

BLOCKED TRIGRAM

S#	1	2	3	4	5	6
1	4	4	8	8	23	23
2	2	3	5	5	6	8
3	2	3	4	9	11	12
4	1	1	1	11	11	13
5	2	2	5	6	6	6
6	1	2	2	2	2	3
7	2	2	2	4	4	4
8	1	5	7	7	13	19
9	2	3	4	6	7	7
10	1	2	2	2	16	20
11	1	1	2	2	3	3
12	1	1	2	2	2	4
13	3	5	14	14	18	18
14	1	1	1	2	4	6
15	2	3	5	5	11	11
16	2	2	4	4	8	8
17	1	3	3	11	11	17
18	2	2	2	2	2	4
19	1	1	2	3	4	4
20	1	1	1	1	2	2
Total	33	47	76	106	164	192
Mean	1.65	2.35	3.80	5.30	8.20	9.60

LIST II TRIALS TO SUCCESSIVE CRITERIA

BLOCKED LETTER

S#	1	2	3	4	5	6
21	2	2	2	3	3	3
22	1	1	1	2	2	2
23	1	2	2	4	5	8
24	1	1	1	1	2	3
25	1	1	1	1	3	4
26	2	2	2	2	8	8
27	1	1	2	2	9	17
28	1	2	2	2	2	3
29	1	2	3	3	7	7
30	1	1	2	3	4	6
31	1	1	1	3	4	7
32	1	1	1	2	4	8
33	1	2	2	3	4	5
34	1	1	2	2	2	3
35	1	1	1	2	4	6
36	2	2	2	3	3	6
37	1	1	2	2	4	6
38	1	1	1	5	5	8
39	1	1	1	2	2	3
40	1	2	2	2	2	4
Total	23	28	33	49	79	117
Mean	1.15	1.40	1.65	2.45	3.95	5.85

LIST II TRIALS TO SUCCESSIVE CRITERIA

RANDOM TRIGRAM

S#	1	2	3	4	5	6
41	1	3	5	7	7	9
42	1	2	5	7	10	20
43	1	1	2	2	3	12
44	1	2	2	5	7	8
45	3	5	8	10	17	19
46	2	2	5	7	14	14
47	1	1	9	9	15	20
48	2	7	16	23	27	28
49	1	3	5	5	10	18
50	1	2	3	3	5	9
51	1	2	2	3	3	6
52	2	3	3	7	9	9
53	1	2	2	2	10	10
54	2	2	2	2	6	7
55	1	2	4	8	8	11
56	1	1	2	2	2	5
57	1	1	1	7	10	10
58	2	2	4	6	7	7
59	1	2	4	4	4	6
60	1	3	3	4	4	19
Total	27	48	87	123	178	247
Mean	1.35	2.40	4.35	6.15	8.90	12.35

LIST II TRIALS TO SUCCESSIVE CRITERIA

RANDOM LETTER

S#	1	2	3	4	5	6
61	1	1	3	3	7	7
62	1	1	1	3	5	5
63	1	4	5	6	8	20
64	1	2	2	11	15	22
65	1	4	12	15	23	26
66	1	2	10	10	18	22
67	1	2	5	5	5	10
68	1	1	2	5	7	7
69	1	1	1	5	7	13
70	3	5	8	16	18	29
71	1	1	1	2	5	5
72	2	3	4	5	5	5
73	1	1	2	4	6	9
74	1	1	2	2	3	4
75	1	2	2	10	12	16
76	1	6	8	8	23	23
77	1	4	4	14	17	19
78	1	2	3	4	5	8
79	1	1	1	2	2	3
80	1	1	4	5	5	7
Total	23	45	80	135	196	260
Mean	1.15	2.25	4.00	6.75	9.80	13.00

PROPORTION OF RESPONSES RECALLED TO STIMULI FROM EACH POSITION OF THE TRIGRAM

In the following data listing these abbreviations were used:

#1.....Number of stimuli from first position recalled when the response was presented

PROP 1.....Proportion of stimuli from the first position recalled when the response was presented

#2.....Number of stimuli from second position recalled when the response was presented

PROP 2.....Proportion of stimuli from the second position recalled when the response was presented

#3.....Number of stimuli from third position recalled when the response was presented

PROP 3.....Proportion of stimuli from the third position recalled when the response was presented

PROPORTION OF RESPONSES RECALLED TO STIMULI
FROM EACH POSITION OF THE TRIGRAM
BLOCKED TRIGRAM

S#	#1	PROP 1	#2	PROP 2	#3	PROP 3
1	2	.333	2	.333	1	.167
2	3	.500	1	.167	2	.333
3	5	.833	3	.500	5	.833
4	2	.333	3	.500	2	.333
5	4	.667	2	.333	1	.167
6	5	.833	2	.333	1	.167
7	5	.833	0	.000	0	.000
8	4	.667	2	.333	0	.000
9	6	1.000	0	.000	1	.167
10	5	.833	2	.333	1	.167
11	2	.333	1	.167	4	.667
12	4	.667	2	.333	5	.833
13	3	.500	2	.333	0	.000
14	5	.833	1	.167	1	.167
15	6	1.000	1	.167	2	.333
16	5	.833	1	.167	1	.167
17	5	.833	0	.000	0	.000
18	4	.667	4	.667	2	.333
19	6	1.000	3	.500	1	.167
20	5	.833	4	.667	3	.500
Total	86	14.331	36	6.000	33	5.501
Mean	4.30	.717	1.80	.300	1.65	.275

PROPORTION OF RESPONSES RECALLED TO STIMULI
FROM EACH POSITION OF THE TRIGRAM
RANDOM TRIGRAM

S#	#1	PROP 1	#2	PROP 2	#3	PROP 3
41	4	.667	1	.167	6	1.000
42	6	1.000	2	.333	1	.167
43	3	.500	1	.167	1	.167
44	5	.833	4	.667	6	1.000
45	6	1.000	0	.000	0	.000
46	6	1.000	3	.500	1	.167
47	5	.833	1	.167	1	.167
48	1	.167	3	.500	1	.167
49	3	.500	0	.000	1	.167
50	5	.833	0	.000	1	.167
51	5	.833	0	.000	0	.000
52	2	.333	1	.167	0	.000
53	6	1.000	1	.167	0	.000
54	6	1.000	0	.000	1	.167
55	3	.500	2	.333	1	.167
56	6	1.000	2	.333	3	.500
57	1	.167	1	.167	2	.333
58	5	.833	1	.167	2	.333
59	6	1.000	0	.000	0	.000
60	6	1.000	0	.000	0	.000
Total	90	14.999	23	3.835	28	4.669
Mean	4.50	.750	1.15	.192	1.40	.234

LIST II PROPORTION OF COMPONENTS

RECALLED WHEN THE RESPONSE WAS PRESENTED

In the following data listing these abbreviations were used:

#NC.....Number of responses correct

#NW.....Number of responses wrong

#CC.....Number of components correct

#CW.....Number of components wrong

PNC.....Proportion responses correct

PCC.....Proportion components correct

LIST II PROPORTION OF COMPONENTS

RECALLED WHEN THE RESPONSE WAS PRESENTED

BLOCKED LETTER

S#	#NC	#NW	#CC	#CW	PNC	PCC
21	5	1	5	1	.833	.833
22	6	0	6	0	1.000	1.000
23	5	1	6	0	.833	1.000
24	5	1	6	0	.833	1.000
25	6	0	6	0	1.000	1.000
26	6	0	6	0	1.000	1.000
27	5	1	6	0	.833	1.000
28	6	0	6	0	1.000	1.000
29	6	0	6	0	1.000	1.000
30	6	0	5	1	1.000	.833
31	6	0	6	0	1.000	1.000
32	6	0	6	0	1.000	1.000
33	5	1	5	1	.833	.833
34	6	0	6	0	1.000	1.000
35	6	0	6	0	1.000	1.000
36	6	0	5	1	1.000	.833
37	6	0	6	0	1.000	1.000
38	6	0	5	1	1.000	.833
39	6	0	6	0	1.000	1.000
40	5	1	6	0	.833	1.000
Total	114	6	115	5	18.998	19.165
Mean	5.70	.30	5.75	.25	.950	.958

LIST II PROPORTION OF COMPONENTS

RECALLED WHEN THE RESPONSE WAS PRESENTED

RANDOM LETTER

S#	#NC	#NW	#CC	#CW	PNC	PCC
61	5	1	4	2	.833	.667
62	3	3	4	2	.500	.667
63	4	2	5	1	.667	.833
64	6	0	6	0	1.000	1.000
65	6	0	6	0	1.000	1.000
66	6	0	6	0	1.000	1.000
67	5	1	5	1	.833	.833
68	6	0	5	1	1.000	.833
69	6	0	6	0	1.000	1.000
70	4	2	3	3	.667	.500
71	5	1	5	1	.833	.833
72	6	0	6	0	1.000	1.000
73	6	0	6	0	1.000	1.000
74	6	0	5	1	1.000	.833
75	6	0	6	0	1.000	1.000
76	6	0	6	0	1.000	1.000
77	6	0	5	1	1.000	.833
78	5	1	5	1	.833	.833
79	6	0	6	0	1.000	1.000
80	5	1	6	0	.833	1.000
Total	108	12	106	14	17.999	17.665
Mean	5.40	.60	5.30	.70	.900	.883

PROPORTION OF COMPONENTS RECALLED

In the following data listing these abbreviations were used:

RN.....Proportion of times one or more components were recalled when the response was recalled

RO.....Proportion of times no components were recalled when the response was recalled

$\bar{R}$N.....Proportion of times one or more components were recalled when the response was not recalled

$\bar{R}$O.....Proportion of times no components were recalled when the response was not recalled

$\bar{R}$NA.....Proportion of times one or more components were recalled when the response was not recalled for attended components only

$\bar{R}$OA.....Proportion of times no components were recalled when the response was not recalled for attended components only

PROPORTION OF COMPONENTS RECALLED

BLOCKED TRIGRAM

S#	RN	RO	$\bar{R}$N	$\bar{R}$O	$\bar{R}$NA	$\bar{R}$OA
1	.600	.400	.769	.231	.500	.500
2	.000	1.000	.833	.167	.714	.286
3	.154	.846	1.000	.000	1.000	.000
4	.429	.571	.636	.364	.500	.500
5	.143	.857	.364	.636	.222	.778
6	.375	.625	.700	.300	.000	1.000
7	.800	.200	.923	.077	.000	1.000
8	.333	.667	.833	.167	.333	.667
9	1.000	.000	.909	.091	.000	1.000
10	.375	.625	.900	.100	.750	.250
11	.429	.571	.909	.091	.500	.500
12	.091	.909	.714	.286	.500	.500
13	.400	.600	.923	.077	.750	.250
14	.429	.571	1.000	.000	1.000	.000
15	.222	.778	.889	.111	.750	.250
16	.571	.429	.909	.091	.000	1.000
17	1.000	.000	1.000	.000	1.000	.000
18	.000	1.000	.875	.125	.667	.333
19	.200	.800	.875	.125	.667	.333
20	.000	1.000	.833	.167	.750	.250
Total	7.560	12.440	16.800	3.200	10.603	9.397
Mean	.378	.622	.840	.160	.530	.470

PROPORTION OF COMPONENTS RECALLED

RANDOM TRIGRAM

S#	RN	RO	$\bar{R}N$	$\bar{R}O$	$\bar{R}NA$	$\bar{R}OA$
41	.364	.636	1.000	.000	1.000	.000
42	.556	.444	1.000	.000	1.000	.000
43	.200	.800	.846	.153	.750	.250
44	.067	.933	1.000	.000	1.000	.000
45	1.000	.000	.917	.083	.500	.500
46	.300	.700	.875	.125	1.000	.000
47	.591	.429	.909	.091	.750	.250
48	.667	.333	1.000	.000	1.000	.000
49	.667	.333	.933	.067	.889	.111
50	.333	.667	1.000	.000	1.000	.000
51	1.000	.000	.923	.007	.667	.333
52	.667	.333	1.000	.000	1.000	.000
53	.429	.571	1.000	.000	1.000	.000
54	.857	.143	1.000	.000	.859	.141
55	.333	.667	.667	.333	.500	.500
56	.182	.818	1.000	.000	1.000	.000
57	.500	.500	.786	.214	.400	.600
58	.500	.500	1.000	.000	1.000	.000
59	.667	.333	1.000	.000	1.000	.000
60	1.000	.000	1.000	.000	.859	.141
Total	10.860	9.140	18.860	1.140	17.174	2.826
Mean	.543	.457	.943	.057	.859	.141

PROPORTION OF COMPONENTS RECALLED

WHEN MEDIATION WAS OR WAS NOT POSSIBLE

In the following data listing these abbreviations were used:

#NMN.....Number of nonmediated opportunities

#NMC.....Number of nonmediated components recalled

PCN.....Proportion of components recalled when mediation did not occur

#NMA.....Number of nonmediated, attended opportunities

PCA.....Proportion of attended components recalled when mediation did not occur

#MA.....Number of mediated attended opportunities

#MC.....Number of components recalled when mediation did occur

PMC.....Proportion of components recalled when mediation did occur

PROPORTION OF COMPONENTS RECALLED

WHEN MEDIATION WAS OR WAS NOT POSSIBLE

BLOCKED TRIGRAM

S#	#NMN	#NMC	PCN	#NMA	PCA	#MA	#MC	PMC
1	9	1	.111	3	.333	1	1	1.000
2	2	0	.000	0	*	10	10	1.000
3	10	3	.300	4	.750	15	14	.933
4	7	0	.000	3	.000	7	6	.857
5	1	0	.000	0	*	13	10	.769
6	5	0	.000	1	.000	11	10	.909
7	9	0	.000	0	*	1	1	1.000
8	6	0	.000	0	*	6	6	1.000
9	12	0	.000	2	.000	0	0	*
10	6	0	.000	0	*	10	9	.900
11	12	5	.417	5	1.000	2	1	.500
12	6	0	.000	2	.000	16	16	1.000
13	3	0	.000	0	*	7	4	.571
14	7	0	.000	0	*	7	6	.857
15	10	2	.200	4	.500	8	8	1.000
16	8	0	.000	0	*	6	4	.667
17	10	0	.000	0	*	0	0	*
18	2	0	.000	0	*	18	17	.944
19	6	0	.000	0	*	13	12	.923
20	6	3	.500	3	1.000	18	18	1.000
Total	137	14	1.528	27	3.583	169	153	15.830
Mean	6.85	.70	.076	1.35	.398	8.45	7.65	.879

PROPORTION OF COMPONENTS RECALLED

WHEN MEDIATION WAS OR WAS NOT POSSIBLE

RANDOM TRIGRAM

S#	#NMN	#NMC	PCN	#NMA	PCA	#MA	#MC	PMC
41	12	1	.083	3	.333	10	9	.900
42	11	1	.091	2	.500	7	3	.429
43	5	0	.000	0	*	5	5	1.000
44	6	1	.167	2	.500	24	22	.917
45	11	0	.001	1	.000	1	0	.000
46	13	1	.077	2	.5000	7	6	.857
47	12	2	.167	4	.500	2	1	.500
48	9	1	.111	3	.333	3	1	.333
49	4	0	.000	0	*	2	1	.506
50	9	1	.111	1	1.000	3	3	1.000
51	9	0	.000	0	*	1	0	.000
52	5	1	.200	1	1.000	1	0	.000
53	11	3	.273	3	1.000	3	1	.333
54	13	0	.000	1	.000	1	1	1.000
55	5	1	.200	1	.250	7	5	.714
56	7	0	.000	4	*	15	15	1.000
57	5	0	.000	0	.000	3	3	1.000
58	9	0	.000	1	1.000	7	7	1.000
59	11	1	.091	1	1.000	1	1	1.000
60	12	0	.000	0	*	0	0	*
Total	179	14	1.57	30	7.92	103	84	12.480
Mean	8.95	.70	.079	1.50	.528	5.15	4.20	.657